



Powerline Communications

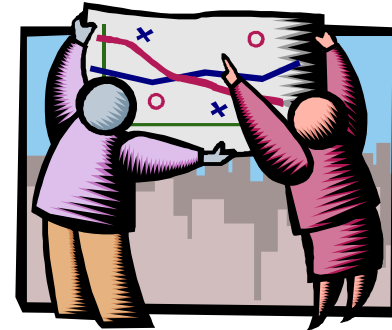
Challenges, Solutions, and Opportunities

Presented by:
Jim McClanahan
of Nortel Networks

jimmcc1@nortelnetworks.com
770-708-4763

Technical Challenges To Powerline Communications Outline

- Introduction
- The Power Budget
- Emissions and Ingress
- The Distribution System
- End-User Issues
- Conclusions



Technical Challenges To Powerline Communications

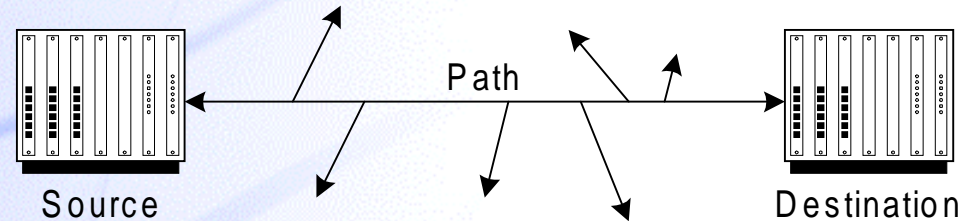
Introduction

- There are several technical challenges to reliable, economical powerline communications.
- In most cases, there are multiple approaches to solving each problem.
- The solutions that are mentioned are not necessarily:
 - the only solutions,
 - the best solutions, or
 - the solutions being pursued by Nortel/NOR.WEB.
- In fact, the problems mentioned may not be the only problems...

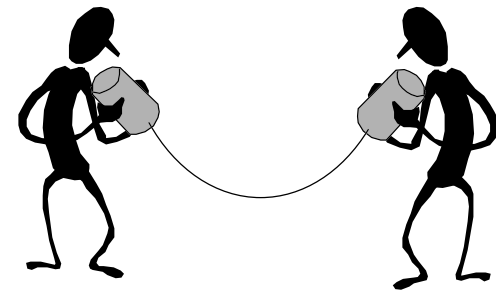
If it was easy, everyone would already be doing it...

Technical Challenges To Powerline Communications

Challenge - The Power Budget



- The diagram above is a simplified view of the Power Budget.
- The source and destination can be two powerline modems.
- The path over the power network may not be a clean, direct path.



Technical Challenges To Powerline Communications

Challenge - The Power Budget

What drives the Power Budget?

- The maximum power that the “transmitter” can inject is limited by Part 15.
- The loss per unit of distance (the path loss) varies with the type of power infrastructure. In the “real-world”, little can be done to improve this.
- The sensitivity of the receiver is typically limited by the noise floor found on the power infrastructure.

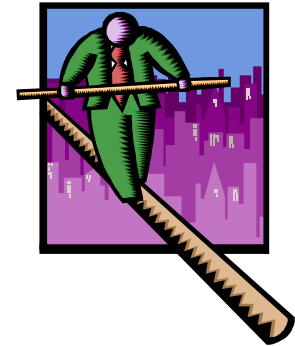
The Power Budget determines “how far” you can communicate.

Technical Challenges To Powerline Communications Solutions - The Power Budget

- May focus on “small footprint” applications such as in-home LANs.
- Different modulation schemes and signal bandwidth could be considered.
- Some type of regeneration or amplification might be used.
- Could seek changes to the emissions limits of FCC Part 15.

Technical Challenges To Powerline Communications

Challenge - Emissions and Ingress



On the one hand...

- **FCC Part 15 sets limits on Emissions.**
- **Even if these limits are met, a device still may not cause harmful interference.**

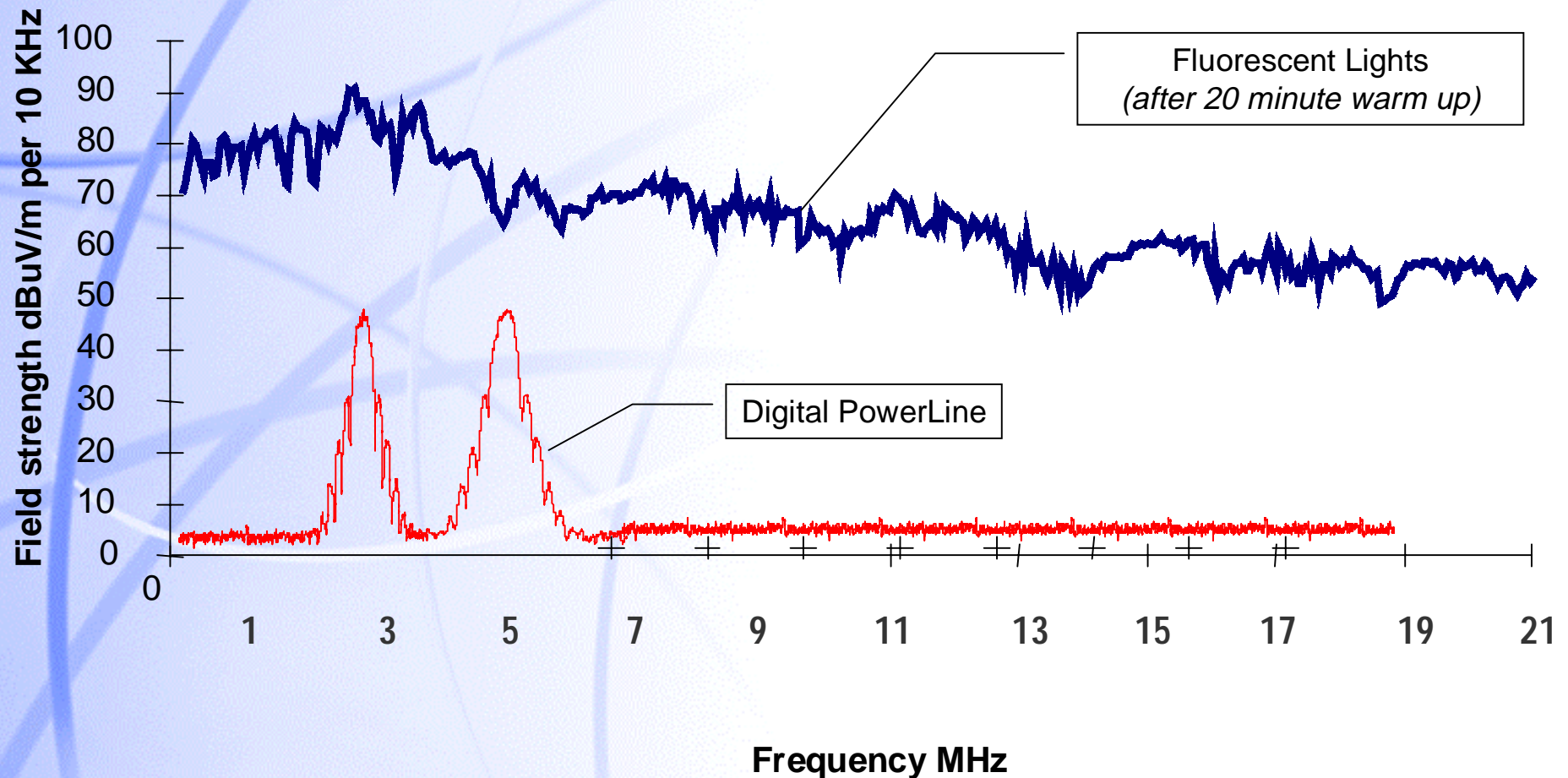
But on the other hand...

- **An unlicensed device must accept any interference it receives.**

The worse of both worlds...

Technical Challenges To Powerline Communications

Challenge - Emissions and Ingress



Signals like ours are little RF fish in a big RF pond...

Technical Challenges To Powerline Communications Solutions - Emissions and Ingress

- Different modulation schemes have different spectral characteristics. FSK tends to concentrate power around the carrier. Spread spectrum
- Make certain the signal gets on the power system-- coupling mismatches will likely be the single “strongest” source of emissions.
- Filters and other ancillary items might reduce emissions.

From an RF perspective, it's a dirty world out there...

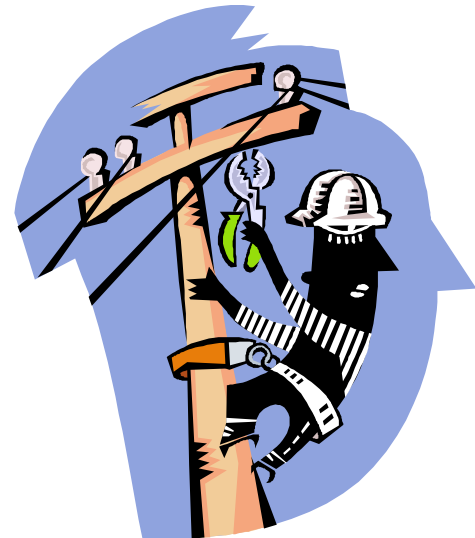
Technical Challenges To Powerline Communications

Challenge - The Distribution System

- In North America, the low-voltage (secondary distribution) system covers a limited area. This may mean that wide deployment will require connection to the high-voltage (primary distribution) system.
- Capacitors are used for VAR compensation on the distribution network. These are typically connected phase-to-neutral and offer an alternate path to ground for signals on the powerline.
- During normal operation and maintenance, switching takes place which alters the topology of the distribution network.

Technical Challenges To Powerline Communications Solutions - The Distribution System

- **Power and telecommunications tend to be different worlds. It takes creativity and teamwork to turn these differences into synergies instead of obstacles.**
- **The power system is the way it is for a number of reasons based on over a century of experience--get over it☺...**
- **Understand the reality...**
 - spend time in the field
 - talk to people
 - look at the system diagrams
 - measure things
 - study operations and maintenance records



Technical Challenges To Powerline Communications

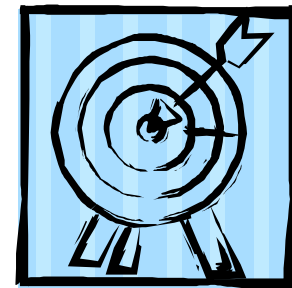
Challenge - End-User Issues

- **How do you interface at the customer end?**
 - plug-in card
 - serial
 - Ethernet
 - USB
- **What types of drivers are required and how are they installed?**
- **Is it easy to use with web browsers, e-mail, etc.?**



Technical Challenges To Powerline Communications Solutions - End-User Issues

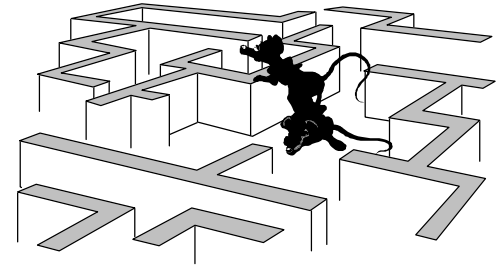
- **Listen to customers.**
- **Look at the market.**
- **Balance multiple objectives:**
 - ease of installation
 - ease of use
 - installed cost
 - flexibility
 - technical elegance
 - technology evolution/avoiding obsolescence



Technical Challenges To Powerline Communications

Conclusions

- **There are lots of challenges, but...**
 - customers want choices,
 - utilities want to diversify their business,
 - regulators want to encourage competition, and
 - telcom service providers want new ways to the customer.
- **The solution of some technical problems may require the assistance of regulators.**



Success comes to those who know
it isn't coming to them and go out
and get it.

-Frank Tyger